Claims

1. A coil configuration for a magnetic resonance imaging system, comprising:

a pair of coils in an opposite rotation orientation associated with a first magnetic field in a region of interest; and

a single coil associated with a second magnetic field in the region of interest, wherein the single coil is positioned at an essentially zero-flux contour with respect to the first magnetic field.

2. The configuration according to claim 1, further comprising:

a means for utilizing the pair of coils for detecting the first magnetic field; and a means for utilizing the single coil for detecting the second magnetic field.

3. The configuration according to claim 1, further comprising:

a means for utilizing the pair of coils for generating the first magnetic field; and a means for utilizing the single coil for generating the second magnetic field.

4. The configuration according to claim 2, further comprising:

a means for utilizing the pair of coils for generating the first magnetic field; and

a means for utilizing the single coil for generating the second magnetic field.

5. The configuration according to claim 2, wherein said coils of said pair of coils and said single coil are selected from the group consisting of: a single turn loop, a multiturn solenoid wound as series loops, and a multiturn solenoid wound as parallel loops.

6. The configuration according to claim 1, wherein each of said pair of coils and said single coil lie in planes parallel to each other, and wherein said essentially zero-flux contour is an essentially zero-flux plane.

7. The configuration according to claim 6, wherein the region of interest is essentially within a cylinder created by the pair of coils, and wherein the pair of coils and the single coil are co-axial.

8. The configuration according to claim 2,

wherein the single coil is a first channel and the pair of coils is a second channel such that coupling between the first channel and second channel is low.

9. The configuration according to claim 8, wherein coupling between the first channel and second channel is approximately zero.

10. The system according to claim 1, wherein the zero-flux contour is located between the pair of coils.

11. The system according to claim 1, wherein the zero-flux contour is located outside the pair of coils.

12. The system according to claim 10, wherein a second zero-flux contour with respect to the first magnetic field is located outside the pair of coils, further comprising a second single coil for generating a third magnetic field in the region of interest, wherein the second single coil is positioned at the second zero-flux contour with respect to the first magnetic field.

13. The configuration according to claim 10,

wherein the single coil is positioned approximately equidistance from each of the pair of coils.

14. The configuration according to claim 10, wherein the single coil is positioned closer to one of the coils of the pair of coils than to the other.

15. The configuration according to claim 1, further comprising:

at least one Helmholtz coil pair associated with a third magnetic field essentially orthogonal to the first and second magnetic fields in the region of interest.

16. The configuration according to claim 15, further comprising a means for utilizing said at least one Helmholtz coil pair for generating the third magnetic field.

17. The configuration according to claim 15, wherein said Helmholtz coil pair is of a configuration selected from the group consisting of: large loops, top/bottom loops, side by side loops, and a combination thereof.

18. The configuration according to claim 1, further comprising:

a crossed ellipse coil pair associated with a third magnetic field and a fourth magnetic field in the region of interest.

19. The configuration according to claim 18, further comprising:

a means for utilizing said crossed ellipse coil pair for detecting the third magnetic field and the fourth magnetic field.

20. The configuration according to claim 18, further comprising:

a means for utilizing the crossed ellipse coil pair for generating the third magnetic field and the fourth magnetic field.

21. The configuration according to claim 18,

wherein the configuration of the crossed ellipse coil pair is selected from the group consisting of an opposite current crossed ellipse configuration and a co-rotating crossed ellipse configuration.

22. The configuration according to claim 18,

wherein the configuration of the crossed ellipse coil pair is selected such as to support a driving current for producing fields consistent with an opposite current crossed ellipse configuration and a co-rotating crossed ellipse configuration.

23. The configuration according to claim 18,

wherein said system is designed for use in a static external magnetic field, and wherein said crossed ellipse coil pair is positioned such that a line connecting a first crossing and a second crossing of the crossed ellipse coil pair is parallel with said static external magnetic field.

24. The configuration according to claim 18,

wherein the pair of coils is isolated via symmetry from the crossed ellipse coil pair of and the single coil.

25. The configuration according to claim 1,

wherein said pairs of coils are connected together by a pair of electrical conductors to form an Alderman-Grant coil pair.

26. The configuration according to claim 1, further comprising:

a switching means for allowing the pair of coils and the single coil to operate in and switch between two or more of the modes in the group consisting of:

(i) the coils of the pair of coils and the single coil having currents rotating in the same direction;

(ii) the coils of the pair of coils having currents rotating in the same direction, with the single coil operating independently;

(iii) the coils of the pair of coils having currents rotating in opposite directions, with the single coil operating independently; and

(iv) the coils of the pair of coils having currents rotating in the same direction and the single coil having a current rotating in an opposite direction with respect to the currents of the pair of coils.

27. A coil configuration for a magnetic resonance imaging system, comprising:

a pair of coils in an opposite rotation orientation associated with a first magnetic field in a region of interest; and

a crossed ellipse coil pair associated with a second magnetic field in the region of interest.

28. The configuration according to claim 27,

wherein the pair of coils is isolated via symmetry from the crossed ellipse coil pair.

29. A coil configuration for a magnetic resonance imaging system, comprising:

a crossed ellipse coil pair;

a means for utilizing the crossed ellipse pair for detecting magnetic fields associated with a first linear mode;

a means for detecting utilizing the crossed ellipse coil pair for magnetic fields associated with a second linear mode;

wherein said second linear mode is orthogonal to said first linear mode; and

a means for utilizing the crossed ellipse coil pair for detecting magnetic fields associated with an opposite rotating mode.

30. The coil configuration according to claim 29;

wherein the opposite rotating mode is isolated from the first and second linear modes due to zero mutual inductance.

31. The coil configuration according to claim 29, further comprising a second crossed ellipse coil pair aligned with the first crossed ellipse coil pair, wherein the means for

detecting magnetic fields associated with the opposite rotating mode utilizes the second crossed ellipse coil pair.

32. A coil configuration for a magnetic resonance imaging system, comprising:

a single coil associated with a first magnetic field in a region of interest; and

a crossed ellipse coil pair associated with a second magnetic field and a third magnetic field in the region of interest.

33. The configuration according to claim 32, further comprising:

a capacitive network which minimizes mutual inductance between the single coil and the crossed ellipse coil pair.

34. The configuration according to claim 32,

wherein the configuration of the crossed ellipse coil pair is selected from the group consisting of an opposite current crossed ellipse configuration and a co-rotating crossed ellipse configuration.

35. The configuration according to claim 32,

wherein the configuration of the crossed ellipse coil pair is selected such as to support a driving current for producing fields consistent with an opposite current crossed ellipse configuration and a co-rotating crossed ellipse configuration.

36. The configuration according to claim 1, further comprising:

at least one additional pair of coils, wherein said pair of coils in an opposite orientation has odd symmetry with respect to a plane,

wherein each of said at least one additional pair of coils is associated with a corresponding at least one additional magnetic field,

wherein each of said at least one additional pair of coils has even symmetry with respect to the plane and is associated with one of said at least one additional magnetic field

such that said single coil is a first channel, said pair of coils in an opposite orientation is a second channel, and each of said at least one additional pair of coils is an additional channel which is orthogonal to the first channel, second channel, and each of the other additional channels.

37. The configuration according to claim 1, further comprising:

at least one additional pair of coils, wherein said pair of coils in an opposite orientation has odd symmetry with respect to a plane,

wherein each of said at least one additional pair of coils is associated with a corresponding at least one additional magnetic field,

wherein each of said at least one additional pair of coils has odd symmetry with respect to the plane and is associated with one of said at least one additional magnetic field such that said single coil is a first channel, said pair of coils in an opposite orientation is a second channel, and each of said at least one additional pair of coils is an additional channel which is orthogonal to the first channel, second channel, and each of the other additional channels.

38. A coil configuration for a magnetic resonance imaging system, comprising:

a plurality of coils with bilateral symmetry,

wherein said plurality of coils is associated with a plurality of modes such that the number of modes is less than or equal to the number of coils, wherein said plurality of modes correspond with a plurality of current patterns, each of said plurality of current patterns having zero net mutual inductive coupling to each of the other of said plurality of current patterns in a region of interest.

39. The configuration according to claim 38, further comprising:

a means for utilizing the plurality of coils for detecting magnetic fields associated with the plurality of current patterns.

40. The configuration according to claim 38, further comprising:

a means for utilizing the plurality of coils for generating magnetic fields associated with the plurality of current patterns.

41. A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps:

detecting a first magnetic field in the field of interest utilizing a pair of coils in an opposite rotation orientation associated with the first magnetic field in a region of interest; and

detecting a second magnetic field in the region of interest utilizing a single coil associated with the second magnetic field in the region of interest,

wherein the single coil is positioned at an essentially zero-flux contour with respect to the first magnetic field.

42. A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps:

detecting a first magnetic field in a region of interest utilizing a pair of coils in an opposite rotation orientation associated with the first magnetic field in the region of interest; and

detecting a second magnetic field and a third magnetic field in the region of interest utilizing a crossed ellipse coil pair,

wherein one of the coils of the crossed ellipse coil pair is associated with the second magnetic field and the other of the coils of the crossed ellipse coil pair is associated with the third magnetic field.

43. A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps:

detecting magnetic fields associated with the first linear mode of a crossed ellipse coil pair;

detecting magnetic fields associated with a second linear mode of the crossed ellipse coil pair; and

detecting magnetic fields associated with an opposite rotating mode of the crossed ellipse coil pair,

wherein the second linear mode is orthogonal to the first linear mode.

44. A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps:

detecting a first magnetic field in a region of interest utilizing a single coil associated with the first magnetic field in the region of interest; and

detecting a second magnetic field and a third magnetic field in a region of interest utilizing a crossed ellipse coil pair,

wherein one of the coils of the crossed ellipse coil pair is associated with the second magnetic field and the other of the coils of the crossed ellipse coil pair is associated with the third magnetic field.

45. A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps:

positioning a plurality of coils with respect to a region of interest such that the plurality of coils support a plurality of modes corresponding to a plurality of current patterns; and

detecting the plurality of modes associated with the plurality of coils,

wherein the number of coils is greater than or equal to the number of modes, and wherein each of the plurality of current patterns has zero net mutual inductive coupling to each of the other of the plurality of current patterns in a region of interest.